

ESTIMATING MONEY DEMAND FUNCTION OF BANGLADESH

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ABSTRACT

Although money demand equations have been estimated for many western countries, yet only recently many researchers have investigated the demand for money in mixed economies like Bangladesh. Co-integration technique is now a common method of estimating any money demand function. This paper empirically analyses the stability of the narrow and broad money demand functions (M1, M2, and M3) in Bangladesh for the period 1999Q1-2005QIII. To determine whether the policy framework satisfies the necessary condition for effectiveness of monetary policy, the stability of Bangladeshi M1, M2, and M3 money demand is estimated and tested by employing a recent co-integration procedure proposed by Johansen-Juselius (2001). It is shown that even though M1 and M2 monetary aggregates are co-integrated with income, interest rate and nominal effective exchange rate, application of Cumulative Sum (CUSUM) and Cumulative Sum of Square (CUSUMSQ) tests to the residuals of an error-correction model reveal that it is unstable.

Key words: Unit root, co-integration, money demand, Stability.

I. INTRODUCTION

There is no single "correct" measure of the money supply: instead, there are several measures, classified along the field of 'narrow' and 'broad monetary aggregates'. Narrow measures include only the most liquid assets, the ones most easily used to spend (currency, checkable deposits). Broader measures add less liquid types of assets (certificates of deposit, etc.). In the money supply statistics, central bank money is MB while the commercial bank money is divided up into the M1-M3 components.

Generally, the types of commercial bank money that tend to be valued at lower amounts are classified in the narrow category of M1 while the types of commercial bank money that tend to exist in larger amounts are categorized in M2 and M3, with M3 having the largest. The stable money demand function ensures that the money supply would have predictable impacts on other economic variables such as inflation, interest rates, national income, private investments, and so forth. (Driscoll and Ford, 1980). In late 2005, Bangladesh bank (the country's central bank) formalized the framework for the conduct of monetary policy to achieve what is called 'price stability with the highest sustainable output growth'. Economic and

financial reforms since the late 1970s in Bangladesh have brought about major changes in the conduct of Bangladeshi monetary policy. Hossain (2006) employed Engle-Granger co-integration technique to show that in case of Bangladesh, while M1 monetary aggregate is cointegrated with its determinants, M2 is not. However, when Hosain and Younus (2008) employed Johansen-Juselius cointegration technique they found reversed of Hossain's (2006) results and concluded that "a stable long-run relationship exists for M2, but not M1". Like all above mentioned studies, however, Lee and Chung (1995) interpreted existence of a co-integrating vector as a sign of stable long-run relationship between M2 and its determinants. However, as Bahmani-Oskooee and Bohl (2000) demonstrate for German money demand function, cointegration among a set of variables does not necessarily imply a stable function. One must apply statistical tests for stability of long-run as well as short-run estimated elasticities to determine whether they are stable over time.

Although there are various sources of instability, the paper mainly focuses on the issue of instability from a methodological perspective. Thus, it is the main purpose of this paper to investigate the stability of M1, M2 and M3 demand for money in

Bangladesh. In doing so close attention is given to Laidler who argued that some of the problems of instability in the money demand function could stem from inadequate modeling of the short-run dynamics characterizing departures from the long-run relationship. The implication is that in cointegration analysis when we try to test for constancy of long-run parameters, we better incorporate the short-run dynamics into the testing procedure. This procedure and the money demand model is explained in section 2 with empirical results in section 3. Section 4 concludes and the data sources are cited in an appendix.

II. ECONOMETRIC MODEL

In formulating money demand function, Bahmani-Oskooee and Rhee (1994) is followed and assumed that the demand for money depends on a measure of income, interest rate and exchange rate. Thus, the following formulation in log linear form is adopted:

$$\ln M_t = \alpha + b \ln Y_t + c \ln r_t + d \ln NEX_t + \lambda t \quad (1)$$

where M is the real monetary aggregate (M1, M2 and M3); Y is the real income (here industrial production data) with expected positive elasticity, r

is a measure of opportunity cost of holding money, i.e., interest rate with expected negative elasticity and NEX is nominal effective exchange rate with expected positive or negative elasticity.

It has been argued that a depreciation of domestic currency (i.e., a decrease in NEX) results in an increase in domestic currency value of foreign financial assets held by domestic residents. In estimating (1) we employ Johansen-Juselius (1990) cointegration analysis rather than Engle-Granger (1987) method. The former is preferred to the later in that not only it allows feedback effect among variables, but also it is based on maximum likelihood estimation rather than OLS. Furthermore, Engle-Granger OLS based method cannot identify multiple cointegrating vectors that may exist among set of variables whereas, Johansen's technique is able to identify multiple cointegrating vectors (if exist). Johansen and Juselius (1990) basically introduce two test statistics known as λ -max and trace to identify number of cointegrating vectors. Once cointegration is established, we borrow the stationary residuals from cointegrating vector and form an error-correction model of the following type:

$$\Delta \ln M_t = a + \sum_{i=1}^n b \Delta \ln M_{t-i} + \sum_{i=1}^n c \Delta \ln Y_{t-i} + \sum_{i=1}^n d \Delta \ln r_{t-i} + \sum_{i=1}^n e \Delta \ln NEX_{t-i} + \lambda EC_{t-1} + \varepsilon \dots \dots (2)$$

concisely, not reducing the figures to a size at which their labels are difficult to read. Use a light pencil to write the page number on the hard copy.

Where λ is the speed of adjustment parameter and EC is the residuals that are obtained from the estimated co-integration model.

Pesaran and Pesaran (1997) then suggest employing CUSUM or CUSUMSQ tests proposed by Brown, Durbin and Evans (1975) to establish the stability of short-run (coefficient estimates of the first differenced variables) as well as the long-run (coefficient of EC_{t-1}) parameters in equation (2). The sample period is broken and the CUSUM and CUSUMSQ statistics are updated recursively and are plotted against the break points. If the plot of CUSUM or CUSUMSQ stay within 5% significance level (portrayed by two straight lines whose equations are given in Brown et. al 1975, section 2.3), then the coefficient estimates are said

to be stable. We will rely upon a graphical presentation of these tests in the next section.

III. EMPIRICAL RESULTS AND STABILITY TEST

A. Data

The Data for the study consist of quarterly observations over 1999Q1-2005Q4 period for the narrow (M1) and broad (M2 & M3) measures of money to apply the methodology explained above to M1, M2 and M3 money demand functions.. The sources for all the data are the International Financial Statistics (IFS) CD ROM (2005) and Bangladesh Bank. For the testing of data, Eviews 5.1 Software has been mostly used.

Using quarterly data over 1999Q1-2005Q4 period we try to apply the methodology explained in section 2 to M1, M2 and M3 money demand

functions in Bangladesh in order to determine which monetary aggregate has stable relation with income, interest rate and nominal effective exchange rate. The first practice in applying any cointegration technique is to determine the degree of integration of each variable. To determine the order of integration of variables we employed the Augmented Dickey-Fuller (ADF) test. The test results supported previous research that all variables are non-stationary at their level and stationarity is achieved after first differencing. Thus, we treat each variable as integrated of order one or I(1). The second step is to apply Johansen-Juselius maximum-likelihood procedure to estimate the λ -max and trace statistics to determine whether variables are cointegrated. In doing so we first decide the order of VAR. While Akaike's Information Criterion (AIC) selected maximum four lags as quarterly data has been considered for the research. The cointegration test results for all three monetary aggregates are reported in Table 2.

B. Unit Root Rest

To ensure the use of stationary time series, augmented Dickey- Fuller (ADF) test statistics were computed for the presence of unit roots against the alternative hypothesis that the series are stationary round a linear time trend. The results of these tests are reported in Table 1. From the results the null hypothesis that the series contain unit roots (i.e., are non stationary) cannot be rejected in all cases. We test for unit roots using the familiar Dickey-Fuller test, based on estimating the regression:

$$\Delta X_t = \alpha + \beta X_{t-1} + \varepsilon_t \quad (3)$$

where Δ is the first-difference operator, α is the constant term, X is the log of the variable being tested and ε is a stationary random error term. The null hypothesis of a unit root is rejected when β is significantly negative. Equation (3) is estimated for each of the variables used in our study.' The results, reported in Table I, indicate that the data do not reject the hypothesis of a unit root in the log-levels of each series. When the first-difference version of equation (3) is estimated, the unit root hypothesis is rejected in every instance because for 1st difference of all cases calculated ADF test statistic is greater than their critical value at 5% level of significance. It is to be noted that the hypothesis is rejected only at the 5 percent level of significance. The results in Table I do not reject the hypothesis that all of the series are integrated of order one.

Table I: Unit Root Test Results

Variable	ADF Test Statistic	
	Level	1 st Difference
LnM1	-1.014723	-4.195845*
LnM2	-2.375279	-4.646467*
LnM3	-2.084144	-5.947746*
LnY	-4.447483	-9.115137*
LnR	-1.273444	-5.417019*
LnNEX	-1.397732	-4.664142*

[Note: Critical values are from Fuller (1976: Table 8.5.2). * denotes significance at the 5 percent level. Critical values for the test statistics are -4.25 at 1%, -3.55 at 5% (*) and -3.21 at 10%. They are taken from MacKinnon (1990).]

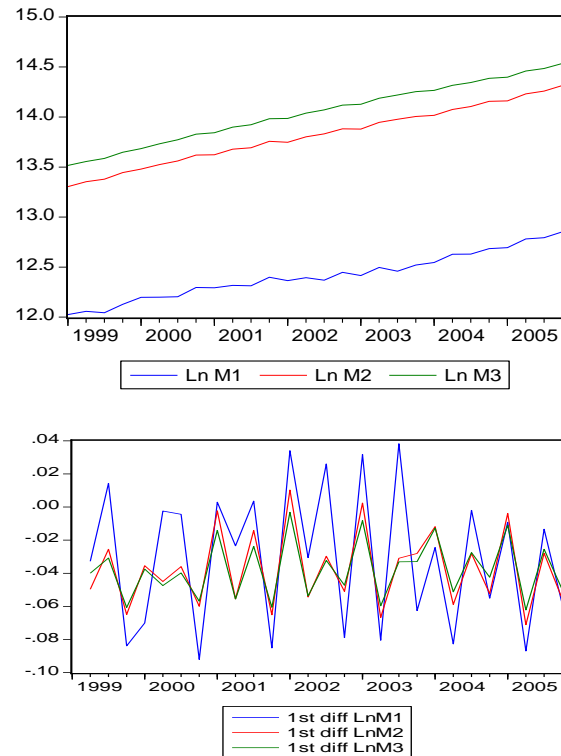


Figure 1: Graphical representation of Ln m1, Ln M2, and LnM3 and their 1st differenced form.

From the figure it is clear that LnM1, LnM2, and LnM3 are to some extent linear trend non-stationary whereas their 1st difference is stationary to look at.

C. Co-integration Test

The second step is to apply Johansen- Juselius maximum-likelihood procedure to estimate the λ -

max and trace statistics to determine whether variables are cointegrated. In doing so we first decide the order of VAR. While Akaike's Information Criterion (AIC) selected maximum four lags as quarterly data has been considered for the research. Thus, following Juselius, we began with one lag, but made sure that the residuals did not suffer from autocorrelation. The cointegration test results for all three monetary aggregates are reported in Table 2.

It is noted that the λ -max and trace statistics should be adjusted for the number of observations, the order of VAR as well as for the number of variables in co-integration space. They suggest multiplying the statistics by $(T-nk)/T$ to obtain the adjusted statistics where T is total number of effective observations, n is number of variables and k is the order of VAR. Thus, throughout the paper we report adjusted statistics. From Panel C, we gather that null hypothesis of no co-integration cannot be rejected by either test because for the null of $r = 0$ the calculated trace value is 54.17381 which is less than its critical value 55.24578.

Though the Calculated max Eigen Value is not less than its critical value, basically based on any of statistic either trace or Eigen value we can reject the null hypothesis. But Panel B reveals that the null of no co-integration among M2 monetary aggregate and its determinants is rejected because for both Trace and Eigen values, the calculated Values are greater than the critical values. In case of M2, for Trace the calculated value is 59.18288 which is greater than the critical value 55.24578 and in case of max Eigen value, the calculated value is 37.85584 which is also greater than its critical value 30.81507. So the null hypothesis is rejected. However, the null of $r = 1$ cannot be rejected in favor of $r = 2$. Thus, there is one co-integrating vector among M2, income, interest rate and nominal effective exchange rate. And the same situation is happened in case of M1. In case of M1, for Trace the calculated value is 63.08474 which is greater than the critical value 55.24578 and in case of max Eigen value, the calculated value is 35.55796 which is also greater than its critical value 30.81507. So the null hypothesis is also rejected here.

Table 2: Johansen's Maximum Likelihood Results (r = number of co-integrating vectors) for All Three Monetary Aggregates

Panel A: The Results of λ -Max and Trace Tests For M1 Money Demand Function

Null	Alternative	λ -Max statistics*	95% Critical Values	Trace Statistics	95% Critical Values
$r = 0$	$r = 1$	35.55796	30.81507	63.08474	55.24578
$r \leq 1$	$r = 2$	15.39696	24.25202	27.52678	35.01090
$r \leq 2$	$r = 3$	11.14785	17.14769	12.12982	18.39771
$r \leq 3$	$r = 4$	0.981973	3.841466	0.981973	3.841466

Panel B: The Results of λ -Max and Trace Tests For M2 Money Demand Function

Null	Alternative	λ -Max statistics*	95% Critical Values	Trace Statistics	95% Critical Values
$r = 0$	$r = 1$	37.85584	30.81507	59.18288	55.24578
$r \leq 1$	$r = 2$	12.06363	24.25202	21.32704	35.01090
$r \leq 2$	$r = 3$	7.607720	17.14769	9.263407	18.39771
$r \leq 3$	$r = 4$	1.655686	3.841466	1.655686	3.841466

Panel C: The Results of λ -Max and Trace Tests For M3 Money Demand Function

Null	Alternative	λ -Max statistics*	95% Critical Values	Trace Statistics	95% Critical Values
$r = 0$	$r = 1$	37.85584	30.81507	54.17381	55.24578
$r \leq 1$	$r = 2$	12.06363	24.25202	16.79647	35.01090
$r \leq 2$	$r = 3$	7.607720	17.14769	7.836968	18.39771
$r \leq 3$	$r = 4$	1.655686	3.841466	2.548980	3.841466

*indicates the max Eigen values

D. Model Estimation

Now the next task is to estimate the parameters of the money demand functions.

Estimation equation for M1 money demand

Estimation Equation:

$$\text{LN_M1} = C(1) * \text{LN_Y} + C(2) * \text{LN_R} + C(3) * \text{LN_NEX}$$

Substituted Coefficients:

$$\text{LN_M1} = 0.385 * \text{LN_Y} - 0.296 * \text{LN_R} + 2.472 * \text{LN_NEX}$$

Estimation equation for M2 money demand

Estimation Equation:

$$\text{LN_M2} = C(1) * \text{LN_Y} + C(2) * \text{LN_R} + C(3) * \text{LN_NEX}$$

Substituted Coefficients:

$$\text{LN_M2} = 0.565 * \text{LN_Y} - 0.016 * \text{LN_R} + 2.75 * \text{LN_NEX}$$

Estimation equation for M3 money demand

Estimation Equation:

$$\text{LN_M3} = C(1) * \text{LN_Y} + C(2) * \text{LN_R} + C(3) * \text{LN_NEX}$$

Substituted Coefficients:

$$\text{LN_M3} = 0.479 * \text{LN_Y} - 0.086 * \text{LN_R} + 2.965 * \text{LN_NEX}$$

The hat on the each of the money demand indicates that it is an estimate.

E. Stability Test

For stability test of the money demand estimation we have done the Cumulative Sum (CUSUM) and Cumulative Sum of Square (CUSUMSQ) of the residuals test. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines whereas the CUSUM of squares test provides a plot of against the pair of 5 percent critical lines. As with The cumulative sum of squares is generally within the 5% significance lines.

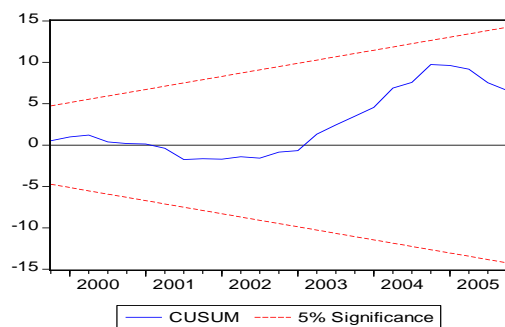


Fig. 2 a) CUSUM for M1 money demand.

After using these coefficient estimates to form the lagged error correction term in equation (2) we performed the CUSUM and CUSUMSQ stability tests for all error correction models

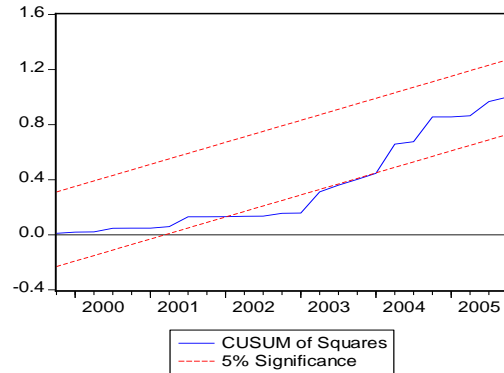


Fig.2 b) CUSUMSQ for M1 money demand

IV. CONCLUSION

This study has examined the concerns about which monetary aggregate best determines the long-run effects of monetary policy actions in Bangladesh. Using a recent single co-integration technique, we able to demonstrate that there is a long-run relationship between the narrow M1 money aggregate and its determinants: national income, interest rate and nominal effective exchange rates. The results suggest that a single co-integrating relationship exists for real money balances (M1 and M2), a scale variable (real GDP i.e. income and exchange rate), and the 4 to 6 months fixed deposit savings rate. This would appear to establish the potential for the central Bank of Bangladesh to achieve its objective of price level stability by controlling the growth rates of either M1 or M2. We employ the CUSUM and CUSUMSQ tests for testing the stability of the long-run coefficient estimates as well as the short-run dynamics of M1, M2 and M3 money demand function in Bangladesh. The empirical results show that in Bangladesh none of the monetary aggregates have a stable relation with income, interest rate and exchange rate. Some studies on developing countries indicated that the models on narrow money worked better since these countries have weak banking system, low level of financial deepening and the large extent of the public economic entities with their own financial resources and budget separate from those of the central government. But in case of Bangladesh,

both banking systems and other financial indicators all are weak enough as a result it is found that except M3, though both M1 and M2 are cointegrated with income, interest rate and exchange rate but M1 and M2 both are unstable.

APPENDIX

All data are quarterly, seasonally adjusted over 1999Q3-2005Q4 period and collected from the following sources:

- a. International Financial Statistics (IFS) CD, 2005.
- b. Home page of Central Bank of Bangladesh (Bangladesh Bank)

Variables:

M = Money supply measured by real M1, M2 and M3. Nominal seasonally adjusted data. The data are adjusted for seasonal variation using Eviews 5.1 program. Y = Real GDP from Industrial Production Data, (source a) r = interest rate from 3-6 months scheduled bank's fixed deposits. NEX = Index of nominal effective exchange rate. Source (a).

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